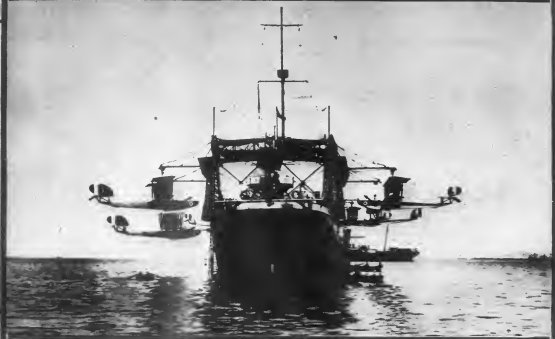


APRIL 1, 1919

PRICE 25 CENTS

AVIATION AND AERONAUTICAL ENGINEERING



Italian Seaplane Carrier Europa
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VOLUME VI
Number 5

SPECIAL FEATURES

COURSE IN AERODYNAMICS AND AIRPLANE DESIGN
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APRIL 1, 1919

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THE GARDNER - MOFFAT COMPANY, Inc., Publishers

HARTFORD BUILDING, UNION SQUARE, 32 EAST SEVENTEENTH STREET, NEW YORK

WASHINGTON OFFICE, EVENING STAR BUILDING

SUBSCRIPTION PRICE: THREE DOLLARS PER YEAR, SINGLE COPIES TWENTY FIVE CENTS. CANADA, THREE AND A HALF DOLLARS. FOREIGN FOUR DOLLARS A YEAR. COPYRIGHT 1919 BY THE GARDNER MOFFAT COMPANY, INC.

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AVIATION AND AERONAUTICAL ENGINEERING

ALFRED H. BROWN
TECHNICAL EDITOR
LEONARD C. COCHRAN
ASSISTANT EDITOR
GEORGE B. BROWN
REVIEWER

Vol. VI

April 1, 1918

No. 5

FOUR years since past runners have been current to the effect that with the general demobilization the Air Service was to be reduced to a mere skeleton, the attention being that the billion dollars of war expenditures spent on the building up of our aircraft program could thus go to other uses.

These runners have fortunately proved unfounded. Not only will the aerial equipment available not be scrapped, but re-equipment will be made for the purchase of 1,000 airplanes of the most modern type, particularly pursuit machines and bombers. The Air Service is woefully lacking in American made machines of this type, for our single seat fighters and night bombers which were used in the war were all of foreign manufacture—a fact which the need for speedy action justified, but which no longer holds true.

The Division of Military Aeronautics also plans to purchase outright sixteen of the present flying fields and maintain the base on two others. In addition facilities will be offered to our mechanics who should wish to enlist in the Regular Army after they have obtained their discharge from the National Army.

All these measures will go a long way to allay fears that the Air Service will drop back to insignificance when the new organization of the Army is carried out.

Requirements of the Mail and Passenger Plane

One of the most interesting problems confronting the mechanical designer at the present moment is the large mail and passenger plane, differing possibly in detail of construction from one another, but belonging to the same class.

From the point of view of technical values, it seems immediately evident that such planes should have large carrying capacity and considerable range in endurance. With small carrying capacity the overhead charges, and the salary of the pilot and of the mechanic figure too largely. Without large range and in view of the fact that either with mail or with passengers time is lost at terminals, the airplane only shows advantage over other types of transportation when a long range is possible. A practical minimum of 2,000 pounds of mail and of ten to fifteen passengers seems to be established, with a range of at least 800 miles. A cruising speed of at least 90 miles an hour seems to be advisable.

This constitutes sufficient specification for the designing engineer. The maximum horsepower with which the above load-carrying capacity and range can be achieved is entirely not less than 100 horsepower in the present stage of the art, and viewing the present available types that exceed two or more Liberty engines

Although this minimum commercial one can be achieved with two Liberty engines, it is a serious question whether three engines are not better than two. A machine equipped with two engines, can in the event of one engine failing achieve its journey only with difficulty, and in the case of contrary winds may make headway very sluggishly. With three engines, two engines at full power would give the equivalent of what would be normally employed at cruising speed. With the failure of one of the engines of a two engine job, the pilot will have considerable difficulty in creating a tendency to spin, and even an extra compensating rudder may not be sufficient to overcome this. With a three engine machine the failure of the central engine will cause no discomfort in navigation at all, while the failure of one of the side engines will be less felt than for a two engine plane.

The introduction of three engines however, complicates the power plant. The problem arises whether the engines should be completely independent of one another, whether separate tanks should be available for each engine, whether these tanks should intercommunicate or not. The machine system thus becomes an engineering very careful study.

Furthermore, with the introduction of three engines, and the consequent possibility of cruising for a long period with one engine out of commission, it becomes a question whether it should not be possible to carry out minor repairs in the air. Around the center engine a swing body or nacelle with a little care can give the mechanic all the space he needs. For the outer engines a gangway or landing should be provided, and when the mechanic does get to the engine some provision must be made to shelter him from the blast of the air.

The employment of multiple engines entails loss in aerodynamic efficiency. It becomes doubtful whether we are right in placing engines out on the wings, and whether it is not better to concentrate a multiple unit power plant, and to utilize a system of clutches working the motors together or separately, driving two propellers on the wings, or other numerous possible combinations.

To secure low landing speeds, yet not enlarge the wing area to such an extent as to destroy high speed, a consideration of movable flaps, or air brakes of one type or another comes to the fore.

Stability, easily achieved with a suitable arrangement of dihedral and fin, becomes highly desirable.

Thus certainly seems to be a number of interesting problems connected with the design of this large type of airplane.

The King 550 Hp. Aircraft Engine

The King 550 hp. aircraft engine, as illustrated in the accompanying photograph and drawings, was designed by Mr. Charles E. King, A. M. E., of the Bureau of Aircraft Production. The aircraft board embarked five of these engines to be built and tested.

The work was started at the plant of Brewster and Company,

Laboratory, pressure test in all bearings. Aluminum case casting. Aluminum cylinder heads. Removable cylinder heads. Removable cylinder heads. No exposed moving parts.

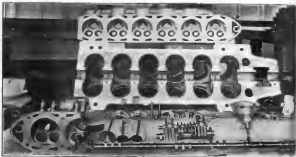


FIG. 1. CRANK CASE AND CYLINDER PORTIONS OF THE KING 550 HP. AIRCRAFT ENGINE

Long Island City, N. Y., and later all parts were shipped to the Ford Field, Dayton, O., for final completion.

The engine is of an extremely interesting type, and its bearing features may be summarized as follows:

The engine will deliver from 300 to 550 hp. in three series, at propeller speeds, varying from 1175 to 1400 r.p.m.

This engine may be installed in an airplane body adapted to the 134 in. Liberty engine. The King engine presents low head resistance and occupies less space. The added horsepower is, therefore, the result of carefully studied design.

Characteristics

Twelve cylinders, four, water-cooled, in cylinders arranged in each bank of a V.

Bore, 3.2 in.; 142 mm.

Stroke, 7 in.; 178 mm.

Bore, stroke ratio, 7 to 3.273.

Engine displacement, 1200 c. in.

Rated horsepower 550—at 1400 r.p.m.; 2000 propeller r.p.m.

Area of one piston head, 23.75 sq. in.

Total piston area, 285 sq. in.

Compression ratio, 5 to 1.

Piston speed at rated hp., 2000 ft. per min.

Horsepower per sq. in. at rated hp., 23.75.

M.P.G. at rated hp., 135 lb.

Camshaft propeller gear ratio, 1.440 to 1 (16 to 26).

Weight of dry engine, 190 lb.

Weight of dry engine at rated horsepower, 184 lb. per hp.

Oil consumption, 50 to 54 lb. per hp./hr.

Oil at maximum, 64 lb. per hp./hr.

Ignition, two independent magneto ignition systems.

Adjustable, adjustable, adjustable. No exposed water or oil connections.

Construction

The main casting of the engine is of aluminum and presents a few engine structural features. The crankshaft is mounted in the base of the engine by means of eight bearings.

The cylinder heads, which are also of aluminum, are cast in detail to the longitudinal and transverse views of the engine. Each cylinder head casting forms the combustion chamber for six cylinders. Three valves per cylinder are mounted in the head, each cylinder head casting is covered (cast) and casted.

The combustion chamber is a set of four valves and jets, mounted at the rear of the main engine casting and covered by a rear cover, which encloses the magneto. The engine also is mounted under the magneto and covers) by means of two main bolts in two cylinder heads.

The cylinder heads are aluminum castings, machined and cast and have a cast iron liner (0.017 in. x 1.1) and thickness. Before casting these cast iron liners in the aluminum body, the barrels are expanded by hot water and the liners are pressed into place. The method of securing the cylinder in the main casting is shown in Fig. 3. Cork packing is used to make the water tight joint at the lower end of the cylinder head. A copper and asbestos gasket is placed under the upper shoulder of each cylinder head. A universal joint rope and asbestos gasket is placed between each cylinder head and the main engine casting.

Each cylinder head is filled with a water, Figs. 2 and 3, which

April 1, 1919

AVIATION

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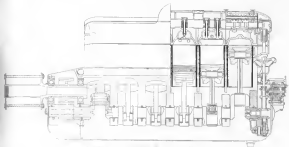


FIG. 2. DISASSEMBLED CROSS-SECTION, SIDE VIEW

can be removed and the clearance between the cylinder and the valve adjusted. The water, which runs on the valve stem, has an adjustable clearance in the rocker arm. Valve stems enter in the main casting, are sized through, in the main casting.

The two of the engine is an aluminum casting. It contains no pump, as this is part of the rear main bearing cap. Provision is made to keep the main dry. Iron oil cooler oil main lines of light, changing change etc.

The propeller arm is strongly reduced in the interior, and the front of the arm is covered by a steel plate.

Pistons

The pistons are of aluminum and of the skidder design and of the skidder type. Five piston rings are used, all short, as a stronger ring in the lower groove. This ring is located in the top, giving a greater seal pressure per square inch, thereby reducing the oil, which is disposed of through a cast-out.

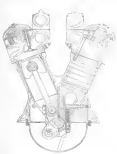


FIG. 3. DISASSEMBLED CROSS-SECTION, SIDE VIEW

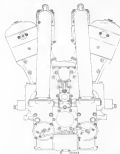


FIG. 4. DISASSEMBLED CROSS-SECTION, SIDE VIEW

the fastest American machine in existence at the date of writing, its high speed being 165.68 m.p.h. For this purpose every effort has been made to provide the most effective wrapping throughout this machine. The sewing wire and all of its associated mechanism. The body is of conventional construction, with the exception of its inside replacing space-frame and transverse. The engine section is built up almost entirely of aluminum, the various levers and supports being of this construction, which is necessarily light for the machine's strength. The forward portion of the body is of special structure section, which is further reinforced by a streamline air making with the airframe. At the pilot's compartment conventional rectangular construction or particularly deep section is used.

Adapters are fitted to the upper wing only, the radiator is disposed in the upper wing. The specifications of the M3-3 are as follows:

General Dimensions—Span, 10 ft. Chord, 5 ft. 4 in. Length, 18 ft.

Weight and Lift—Gross weight, 2,050 lb. Wing area, 230 sq. ft. Wing loading, 8.9 lb./sq. ft. Horsepower required, 440. Power loading, 3.3 lb./hp.

Power Plant—Engine, Hispano-Suiza model II, 340 hp. at 1,200 r.p.m. Fuel capacity, sufficient for 3 hr. at full power, at 165.68 m.p.h.

Performance—High speed, 165.68 m.p.h. Initial climb, 1,600 ft. in 20 sec.; 10,000 ft. in 4 min. 52 sec.

The above performance was made during preliminary tests carried out by Pilot Frank H. Remond at Edwards Air Force Field. The only full load was carried with the exception of 170 lb. of military load.

Armament—Two Browning machine guns, synchronized with the ailerons, and 2,500 rounds of ammunition.

The Edstrom Wire Wrapping Machine

The Edstrom Wire Wrapping Machine was set up and demonstrated, November 10 to 20, 1928, at McCook Field, Dayton, Ohio, where the standard test specimens were tested a few weeks later. The following report made in the Technical Division of the Air Service is based on these tests:

Description

Figure 1 shows the wire wrapping machine which was built by the Edstrom-Wing Manufacturing Co., of Chicago. The



FIG. 1

legs were attached to the temporary wooden base to facilitate frequent handling and shipment between demonstrations.

The first operator in making the wire terminal is to form the loop. For this purpose there is a special handling fixture attached to the rear of the machine. This is partly visible at the extreme left end of Fig. 1. The wire is then fed into the machine, one of which is attached to a wrapping lever. By a quick movement of the lever, the cable is held in the proper form. A forward loop is shown in illustration, mounted on a board which rests on the machine. Two turns of soft wire may be added to the end of the cable. These are always added before cutting a cable to keep the wires from untwisting. They are automatically opened when the wrapping is nearly completed.

After the loop has been formed in the end of the cable, it should be inserted and the end of the cable is gripped firmly in the jaws of the machine. The rest of the cable extends through the rear corner and long tube to the right. The serving wire is fed down a notch provided on the outer side of the machine around a drum and through the serving guide. By adjustment the wire can be wrapped at any desired tension.

Obviously a sheath or tape would be attached to the terminal but while being wrapped. This was not met in the case of the specimens made for test purposes, but it is essential that the jaws and headstock be able to accommodate any such fitting that is to be attached permanently to the terminal.

The machine is driven by a motor which is fitted to the

base. The head and tail centers are geared together and drive simultaneously. The tail center and feeding guide revolve internally at a speed sufficient to wind the wire as close as desired. The internal motion is adjusted by a set of change gears. Means are also provided for automatically leaving a space in the winding.

For Specimens and Results of Tests

Tables I and II give a complete data, including the description, important dimensions and strength of the various specimens tested.

All specimens were of 18 wire size flexible finishing steel cable. The total length of each specimen was about 20 inches. Tensile tests were made in the regular manner on an Instron testing machine, the load of the machine serving internally at a speed of 10 in. per minute.

The Bureau of Aircraft Production Specification No. 20313-A for the Manufacture of Wrapped Terminals for 4 cable studies in detail the general methods of making test results in specimen cable. Table III gives the tabulated dimensions of the wrapping wire tested from the above specification. The use of soft annealed steel was thoroughly tested as required. Material used in a zinc solution is specified for the flux. The solder is approximately 45 per cent tin and 55 per cent lead. The cable end is to be prepared before wrapping or dip soldered after wrapping, but in any case the use of acid soldering copper is specified for finishing.

It will be noted that the test specimens were made up somewhat differently from the way the specification shows. The serving wire was either copper or unlabeled annealed steel and the served length on all specimens was longer than standard. It is, therefore, probable that the strength of the unwrapped specimens were greater than if there would have been had the serving wire been heated steel wire of the dimensions shown in Fig. 2.

The results of these and other tests are given, particularly about the advantages to be obtained by the use of a machine for wrapping the serving wire, both as to the increased speed with which the operation can be performed and the strength of the finished terminal, but considered terminal. The strength of the standard terminal, the loss is the necessary dependence upon the strength of the solder. It is to be noted that of the ten unwrapped specimens 7½ in. to 7.75 in. only one failed at a load below the rated capacity of the cable. The 7/10 in specimen served with copper wire failed at loads wrapping 71 per cent of the full strength of the cable. A previous test of 5/8 in. as given 3/25 unlabeled handwound terminals served from the Carter Aeroelastic Corp. showed an average strength equal to 80 per cent of the full strength of the cable.

When coils terminals are made in quantities the use of a machine for winding is a great time saver. By the hand method, 15 terminals can be completely finished at the rate of about 12 to 15 per hour, 2/10 terminals at the rate of about 10 to 12 per hour. By the machine method, the rate is easily 30 per hour for the 7/10 to 7/25 sizes.

It was believed that due to the lightness of the machine

wrapping a 100 per cent efficient terminal might be obtained by merely dip soldering the wrapped terminal without soldering any of the lead soldering connection. For this reason, some specimens of each size were dip soldered only. In every case these terminals proved 100 per cent efficient, failure al-

ways entailed one closely wrapped terminal although occasionally by unwrapping the wire has readily shown the solder to be well distributed between turns. When a space is left between turns it is not necessary to remove the wire to make sure that the solder is thoroughly distributed.

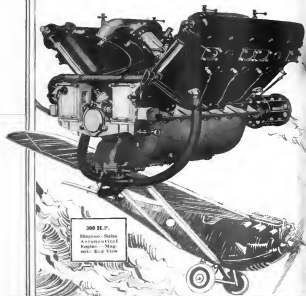
TABLE I. TEST DATA.

Specimen	Wire Size	Material	Actual Dimensions	Serving Wire	Solder	No. Pkgs. 7	Served Length	Strength	Type of Failure
1	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
2	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
3	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
4	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
5	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
6	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
7	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
8	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
9	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
10	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
11	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
12	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
13	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
14	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
15	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
16	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
17	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
18	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
19	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal
20	18	Copper	1.00	Copper	45/55	1/4	1/4	1,000	Cable wire terminal

was occurring in the cable, although considerable distortion to the terminals was necessary. However the appearance of the joints when merely dip soldered was not very satisfactory and was so much as to cause troubles in these strength. The solder did not properly fill in between the wires when wrapped at load points. Severer shock or vibration might weaken such joints.

A large number of specimens were wrapped with a slight space between each turn of the wire. This is contrary to our regular practice

SPEED and



300 H.P.

Hispano-Suiza
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net. End View

ENDURANCE



The brilliant performances of

HISPANO-SUIZA Aeronautical Engines

have been substantially recorded
on several notable occasions.

*These records are milestones in
marking the wonderful progress of
aeronautical achievement in America*

Manufactured by

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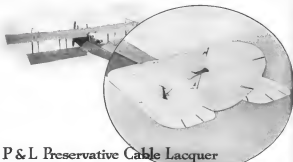
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